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Organic Matter in Jurassic Fish Coprolites

T. Lanzirotti (U. of Chicago), S. Wirick, C. Jacobsen, and G. Hanson (SUNY, Stony Brook)

Beamline(s): X1A

Introduction: The identification of ancient organic matter in fossils is difficult. The organic content in most fossils is low and the extraction of organics from mineral phases is complicated. An optimum tool to identify and map organic content in fossils is carbon x-ray absorption near edge spectroscopy (XANES) and imaging using synchrotron light, where the organic matter can be analyzed in-situ with a spatial resolution of 50 nm.

Results: Thin sections (~200nm thick) of a Jurassic fish coprolite (ca. 198 million years old) preserved in a black shale were analyzed using the X1A scanning transmission microscope at the carbon K edge. Images taken both below the carbon K edge (280ev) and above the carbon K edge (290ev) show a dramatic increase in absorption at 290ev, indicating a high concentration of carbon (Fig. 1). From the images one can also observe the intimate morphological relationship between the carbon bearing material and the non-carbonaceous material, the non-carbonaceous material identified as hydroxyapatite. The coprolite XANES spectra were compared with standard XANES spectra in the X1A database and are similar to carbon XANES spectra of type I, insoluble collagen from bovine Achilles tendon (Fig. 2). The observed shift of the coprolite's C=C, 1sπ^* peak (285.3ev) with respect to the standard collagen's C=C, 1sπ^* peak (284.9ev) is probably due to crosslinking in the coprolite's collagen.

Conclusions: That we observe collagen still preserved after 200 million years is not so surprising. Teeth (dentin) and bone (hydroxyapatite) from organisms that these fish have ingested have been identified in these coprolites and it is known that modern type I collagen is closely associated with the mineral matrix of bone. Subsequent rapid burial and digenesis coupled with anoxic conditions may have isolated the organic matter and minimized decomposition, preserving the collagen.

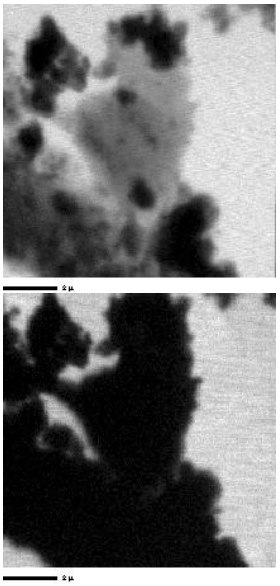

Fig. 1 X-ray absorption images at 280ev (top) and 290ev

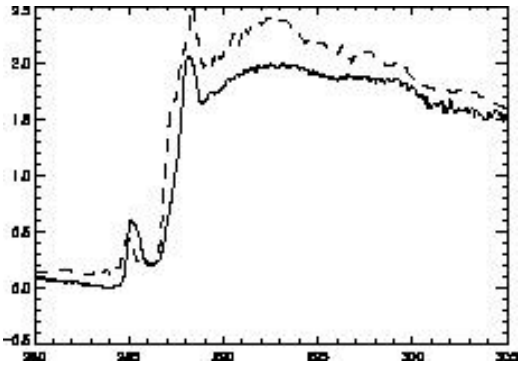

Fig. 2 Comparison coprolite (solid) spectrum with type I collagen